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ORIGINAL ARTICLE

The parasacral sciatic nerve block does not induce anesthesia of the obturator nerve

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Abstract
Purpose The ability of the parasacral sciatic nerve block (PSNB) to induce anesthesia of the obturator nerve remains controversial. Our objective was to evaluate the anesthesia of the obturator nerve after a PSNB.
Methods Forty patients scheduled to undergo knee surgery (anterior cruciate ligament reconstruction) were included in this prospective, randomized, controlled study. Patients were randomized to receive PSNB alone (control group, $n = 20$) or PSNB in combination with an obturator nerve block (obturator group, $n = 20$). After evaluation for 30 min, the two groups received a femoral nerve block, and patients were taken to surgery. The obturator nerve blockade was assessed by measurement of adductor strength at baseline (T0) and every 10 min during the 30-min evaluation (T10, T20, and T30). Pain scores after tourniquet inflation and during surgery were compared between the two groups. The requirement for additional intravenous analgesia and/or sedation was also recorded.
Results The two groups had comparable demographic and surgical characteristics. Four patients were excluded from the study because of PSNB or femoral nerve block failure. The adductor strength values were similar between groups at T0 but were significantly lower in the obturator group at T10, T20, and T30 ($p < 0.0001$). Patients in the obturator group reported less pain than those in the control group ($p < 0.05$). They also required less additional intravenous sedation and/or analgesia ($p < 0.05$).
Conclusion This clinical study demonstrated that the PSNB is an unreliable means of inducing anesthesia of the obturator nerve and emphasizes the need to block this nerve separately to induce adequate analgesia during knee surgery.

Keywords Lower extremity nerve blocks · Regional anesthesia · Parasacral sciatic nerve block · Obturator nerve block · Knee surgery

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Introduction

Regional anesthesia of the lower limb is known to be technically more difficult than neuraxial anesthesia and requires blockade of several different nerves to ensure adequate surgical anesthesia [1, 2]. This process implies an increase in the number of punctures and, consequently, an increase in the patient's discomfort, an increased risk of complications, and a not negligible risk of failure. Recently, several developments have led to increased interest in lower-extremity nerve blocks, in particular, their proven rehabilitative benefits [3, 4].

The difficulty of regional anesthesia for lower-limb surgery is well illustrated by knee surgery, for which it is necessary to perform a combination of three peripheral nerve blocks—femoral, sciatic, and obturator [5]. Clinical studies have revealed that an obturator nerve block (ONB) is essential for knee surgery [6–8]. Among the different approaches to the sciatic nerve, the parasacral sciatic nerve block (PSNB) is an original approach regarded as a sacral plexus block [9]. Success of the PSNB is high and the onset time short; it is also easy to perform [10, 11]. Because of the proximity of the obturator nerve to the sacral plexus in the pelvis, it has been suggested that the PSNB is a reliable

means of producing ONB [12]. If these data were confirmed, the PSNB would avoid the need for a selective ONB. Therefore, knee surgery could be performed after two injections (i.e. a combined parasacral sciatic–femoral block) rather than three injections (i.e. sciatic, femoral, and ONB). Performing regional anesthesia with fewer injections would be attractive for the anesthesiologist. However, results of studies on this topic are contradictory [12–14]. The purpose of our investigation was to test the hypothesis that the PSNB may induce anesthesia of the obturator nerve.

Materiel and methods

This prospective randomized simple blinded study was conducted at the department of anesthesiology of Avicenna Military Hospital. After approval by the local ethics committee and obtaining written informed consent, 40 patients (ASA physical status I, II) scheduled to undergo knee surgery (anterior cruciate ligament reconstruction), under regional anesthesia were included in the study. Exclusion criteria were age <18 years, allergy to local anesthetics (LA), pre-existing neurologic or neuromuscular disease, coagulation disorders, skin infection at the site of puncture, pregnancy, and breast-feeding.

Forty sealed envelopes were prepared and contained the assigned group by randomization. Patients were assigned, by use of a random number generator, to one of two groups. The first group, the obturator group, ($n = 20$) received PSNB followed immediately by an ONB. After a 30-min period of evaluation, a femoral nerve block was performed. The second group, the control group ($n = 20$), received PSNB. And after a 30-min period of evaluation, a femoral nerve block was again performed.

Patients were premedicated with oral hydroxyzine 1 mg/kg 1 h before surgery. In the preanesthesia room, patients were monitored (electrocardiography, pulse oximetry, and automated non-invasive blood pressure) and a venous access was secured. Mild sedation (midazolam 1 mg and fentanyl 25 μg) was administered to prevent discomfort during performance of the blocks.

All blocks were performed by the same experienced anesthesiologist (YA). The PSNB was performed in accordance with the technique described by Mansour [9]. The patient was positioned in the lateral decubitus position, hips and knees flexed, with the leg to be blocked uppermost. A line was drawn from the posterior superior iliac spine to the lowest point of the ischial tuberosity. The puncture site was located 6 cm inferior to the posterior superior iliac spine. After skin disinfection, a 100-mm short-bevel insulated needle (Locoplex; Vygon, Ecouen, France) connected to a nerve stimulator (Plexygon; Vygon, Ecouen, France) was introduced. The needle direction was perpendicular to the skin in all planes. If the needle contacted the bone, it was removed and reinserted 1–2 cm caudally along the line. Only a tibial motor response (plantar flexion of the foot and/or toes) was regarded as adequate [15]. If a peroneal nerve response was obtained (dorsiflexion of the foot and/or toes), the needle was redirected medially to elicit a tibial nerve response. The stimulating current was set initially at 1.5 mA (frequency 1 Hz; time 100 μs). When the correct motor response was obtained, the intensity was gradually reduced. The needle was considered to be adequately positioned when the stimulating current was 0.2–0.5 mA. Twenty-five milliliters of LA mixture containing equal parts of lidocaine 2 % and bupivacaine 0.5 % (actual concentrations: lidocaine 1 % + bupivacaine 0.25 %) was slowly injected through the needle, with careful intermittent aspirations every 5 ml.

The patient was then immediately turned supine, and the obturator group received an ONB in accordance with the inguinal approach described by Choquet et al. [16]. The patient was placed supine with the legs slightly abducted. A mark on the skin was made in the inguinal crease at the midpoint of the line drawn between the inner border of the adductor longus tendon and the femoral arterial pulse. A 50-mm short-bevel insulated needle (Locoplex; Vygon) was inserted at this point in a 30° cephalad direction until contractions of the gracilis or adductor longus muscle were elicited (anterior branch of the obturator nerve). Stimulation was begun by use of a current of 2.0 mA for 100 μs at 1 Hz. The current was gradually reduced until the muscle twitches stopped between 0.2 and 0.5 mA. At that time, 3 ml of the same LA mixture (lidocaine 2 % + bupivacaine 0.5 %) was injected. The needle was inserted more deeply and in a 5° lateral direction until contractions of the adductor magnus muscle were elicited (posterior branch of the obturator nerve) and 3 ml of the LA solution was injected.

An anesthesiologist unaware of patient allocation tested the blocks. The obturator block was evaluated by assessing the adductor strength because sensory testing is unreliable for testing the success of this block [17]. Assessment of the adductor was achieved by use of a mercury sphygmomanometer, as described by Lang et al. [18]. Patients were asked to extend the hips and knees, then to squeeze a blood pressure cuff, previously inflated to 40 mmHg, between their knees. The maximum sustained pressure generated was recorded as an index of adductor muscle strength. The investigator resisted the patient's attempt to adduct the contralateral leg toward the midline to ensure that the pressure generated on the mercury sphygmomanometer corresponded to the blocked leg only. Baseline measurement of adductor muscle strength was performed before completion of the blocks. The adductor's strength was

evaluated at baseline (T0), 10, 20, and 30 min (T10, T20, and T30, respectively) after PSNB for the control group and after PSNB + ONB for the obturator group.

The sciatic block was assessed at T30. The sensory block was assessed by use of a cold test with a swab soaked in alcohol in the peripheral sensory distribution of the sciatic nerve: posterior cutaneous nerve of the thigh (posterior femoral cutaneous area), tibial nerve (plantar side of the foot), common peroneal nerve (lateral cutaneous side of the calf), and superficial peroneal nerve (dorsal aspect of the foot). Sensory block was determined by use of a rating scale: 0, normal sensation; 1, blunted sensation; and 2, absence of sensation (anesthesia). Motor block was also tested: plantar flexion of foot (tibial nerve) and dorsiflexion of foot (peroneal nerve). If the sensory block was not 2 in at least one of the sciatic areas, the sciatic block was considered incomplete and the patient was excluded from the study.

After these 30-min evaluations, a femoral nerve block using the classic paravascular technique was performed [19]. A 50-mm insulated needle was inserted just lateral to the fingertip palpating the femoral artery. Stimulation was begun using a current of 1.5 mA for 0.1 ms at 1 Hz. The needle was advanced cephalad in a sagittal plane at a 30° angle to the skin until an appropriate motor response (quadriceps muscle contraction with patellar ascension) was elicited. The current was reduced until muscle twitches stopped at 0.2–0.5 mA. Fifteen milliliters of the same LA mixture (lidocaine 2 % + bupivacaine 0.5 %) was slowly injected with intermittent aspirations every 5 ml. The adequacy of femoral nerve block was tested 15 min later by the presence of paralysis of the quadriceps muscle (knee extension) [20]. In the event of femoral nerve block failure (incomplete quadriceps paralysis), the patient was excluded from the study.

The surgery was performed by using a standard thigh tourniquet inflated 150 mmHg higher than systolic blood pressure. Patients were asked to assess their pain after tourniquet inflation and during surgery by use of an 11-point numeric rating scale (NRS: 0, no pain; 10, worst pain imaginable). Patients could receive bolus intravenous injections of midazolam (1–2 mg) and fentanyl (50 μg) if the pain scores were higher than 4, or if they felt uncomfortable. General anesthesia was delivered if surgical anesthesia was deemed inadequate. Evaluation of pain and intraoperative management was performed by a third anesthesiologist unaware of the group allocation.

Demographic and surgical data sex, age, ASA status, weight, height, and side and duration of surgery were recorded. The pain scores after tourniquet inflation, the maximum pain scores during surgery, the number of patients requiring additional intravenous sedation and/or analgesia or general anesthesia and the doses of midazolam or fentanyl administered were also noted.

Sample size calculation was based on previous research [13]. In that study, the PSNB was responsible for 11 % of the loss of adduction and the ONB for 69 %. Therefore, to detect a clinically significant reduction in adductor strength from 10 to 60 % it was necessary to recruit 17 patients per group (5 % level of significance with 80 % power). We decided to include 20 patients per group. Sample size was calculated by use of Primer of Biostatistics Statistical Software, version 4.02 (McGraw–Hill, San Francisco, CA, USA).

Results were expressed as mean ± SD or median (range), depending on their distribution. Qualitative variables were compared by use of the chi-squared test or Fischer's exact test. Quantitative variables were compared by use of the Student t test or the Mann–Whitney U test if the distribution was non-Gaussian. Values of adductor strength were compared by analysis of variance for repeated measures. Significance for all statistical tests was set at $p = 0.05$. Analysis of data was performed by use of SPSS for Windows (Version 10; SPSS, Chicago, IL, USA).

Results

Forty patients scheduled to undergo anterior cruciate ligament reconstruction were enrolled in the study. There were no differences in the demographic or surgical variables between the two groups (Table 1). Successful nerve identification for the FNB and for the PSNB was achieved for all patients. Data related to PSNB and FNB (minimum intensity of stimulation and depth of nerve localization) were comparable between the two groups. ONB was achieved for all patients of the obturator group. Four patients were excluded from the study because of PSNB or FNB failure, one patient in the obturator group (1 FNB failure) and three patients in the control group (1 FNB failure and 2 PSNB failures). The differences between the two groups regarding failure of nerve blocks were not significant.

Table 1 Demographic and surgical data

	Obturator group ($n = 20$)	Control group ($n = 20$)	p
Age (years)	35 ± 15	36 ± 13	0.85
Sex (M/F)	16/4	17/3	1
ASA physical status (I/II)	18/2	16/4	0.65
Height (cm)	172 ± 4	171 ± 5	0.89
Weight (kg)	74 ± 11	74 ± 10	0.96
Limb (right/left)	13/7	15/5	0.73
Surgical time (min)	68 ± 25	73 ± 31	0.57

Continuous variables are mean ± SD

Baseline values of adductor strength were similar between the two groups. Adductor strength values were significantly lower at T10, at T20, and at T30 in the obturator group than in the control group (Fig. 1). Thirty minutes after PSNB for the control group and 30 min after PSNB + ONB for the obturator group, adductor strength had decreased by 79 ± 11 % in the obturator group and by 21 ± 10 % in the control group ($p < 0.0001$).

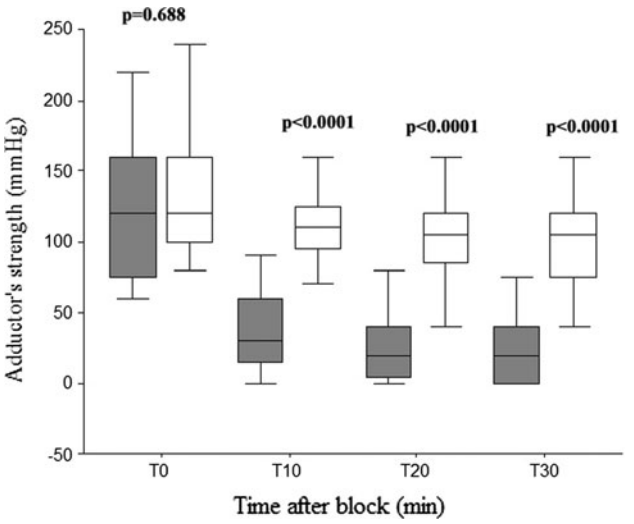

Fig. 1 Comparison of adductor strength at baseline (T0), at 10, 20, and 30 min (T10, T20, T30) after parasacral sciatic nerve block for the control group (*grey box plots*), and after parasacral sciatic nerve block + obturator block for the obturator group (*white box plots*). *Box plots* show the median (*solid line*), 25th and 75th percentiles (*lower and upper limits of the box*), and the minimum and maximum observations (*whiskers*)

Table 2 Pain scores during surgery and additional sedation and/or analgesia required

	Obturator group ($n = 19$)	Control group ($n = 17$)	p
NRS after tourniquet inflation	0 (0–0)	0 (0–4)	0.041
NRS during surgery	0 (0–1)	6 (0–7)	0.030
Midazolam (no. of patients)	6 (30 %)	15 (75 %)	0.011
Dose of midazolam required (mg)	0 (0–2.5)	2 (0–3)	0.048
Fentanyl (no. of patients)	5 (25 %)	13 (65 %)	0.026
Dose of fentanyl required (μg)	0 (0–37.50)	50 (0–100)	0.022
General anesthesia required (no. of patients)	0	3	0.230

Continuous variables are presented as median (25th percentile–75th percentile)

NRS numeric rating scale

Patients in the obturator group reported significantly lower pain scores than those in the control group after tourniquet inflation and during surgery (Table 2). In addition, patients in the obturator group required significantly less additional intravenous sedation and/or analgesia than the control group. The dose of midazolam and fentanyl administered was also significantly lower in the obturator group than in the control group (Table 2). General anesthesia was required by two patients in the control group and no patients in the obturator group ($p > 0.05$). No complication related to LA was recorded.

Discussion

This prospective randomized study has demonstrated that association of a selective ONB with a PSNB resulted in a significant decrease in adductor strength and lower peroperative pain. These results suggest that the PSNB does not induce consistent anesthesia of the obturator nerve.

The obturator nerve is important in peroperative pain for all procedures on the knee, because it induces sensory innervation of the medial part of the knee joint [21]. It has been demonstrated that addition of ONB to FNB improves both intraoperative and postoperative analgesia after knee surgery [6–8]. In our study, we did not include all knee surgical procedures, but only anterior cruciate ligament reconstruction, to have a homogenous population with a comparative peroperative pain.

Morris et al. suggested that the PSNB could spread to the obturator nerve, because of the proximity of the two structures. Indeed, the obturator nerve courses along the pelvic brim close to the sacral plexus [12, 13]. Our study, however, contradicted this by demonstrating the absence of obturator anesthesia after PSNB, probably because the LA did not spread to the obturator nerve. The presence of a deep pelvic fascia separating these two neural structures could be a plausible explanation [13]. In the study of Morris et al., 73 % of patients had marked adductor motor weakness after PSNB suggesting possible anesthesia of the obturator nerve. However, adductor strength was assessed subjectively [12]. Furthermore, it has been demonstrated that the sciatic plexus itself is responsible for at least 30 % of adductor strength [21]. Our study confirmed this, because the PSNB was accountable for 21 % of loss of adductor muscle strength.

Other factors that could explain the negative result of our study could be the volume and/or the concentration of LA used to perform the PSNB. The lack of spread to the obturator nerve may be because of the low volume (25 ml) of LA administered in our study. This is less than that used in the study by Morris et al. (30 ml) but is consistent with those in other studies describing the PSNB [10, 11, 13]. The

concentration of LA may also affect the success of the sciatic nerve blockade. It has been demonstrated that low volume and high concentration of LA are more efficacious than high volume and low concentration in sciatic nerve block [22]. Despite the low LA concentration used in our study (bupivacaine 0.25 % + lidocaine 1 %), the success of PSNB was 95 %. The effect of LA concentration or volume on ONB success can probably be excluded in our study.

A clinical study by Jochum et al. [13], demonstrated the unreliability of PSNB in achieving anesthesia of the obturator nerve. The authors examined their hypothesis by giving ONB to the same patients after performing PSNB. Therefore, the possibility that the effect of ONB may simply be delayed cannot be completely rejected. In contrast, our study investigated the effect of PSNB on the obturator nerve by comparing two groups with or without ONB, which makes the conclusion of our study more objective. Furthermore, unlike the study by Jochum et al., we sought to evaluate both the motor component (adductor's strength) and the sensory component of the obturator nerve by comparing pain scores of the two groups during surgery. It is now well demonstrated that sensory evaluation of the obturator nerve by assessing its cutaneous sensation is unreliable [15]. Indeed, the cutaneous innervation of the obturator nerve is present in only 43 % of patients. This cutaneous territory is very variable and may correspond to the medial aspect of the thigh or the superior part of the popliteal fossa [15].

We found that adductor strength decreased very significantly in the obturator group compared with the control group, which suggests the absence of obturator anesthesia in this latter. However, we hypothesized that it could be possible to have a selective obturator sensory block without motor block. In fact, the extent of obturator motor block is not necessarily related to that of sensory block. But, higher intraoperative pain scores in the control group definitely confirmed the lack of ONB in this group.

Another difference from the study by Jochum et al. is that the obturator block was performed using the inguinal approach described by Choquet et al. [16]. This technique significantly reduces discomfort and pain during application of the block to achieve a similar quality of ONB compared with the classic pubic tubercle approach.

A recent anatomical study increased the controversy concerning the ability of the PSNB to induce obturator nerve anesthesia [14]. Fourteen parasacral injections using latex diluted with water were performed bilaterally on seven human cadavers. After an endopelvic dissection, the dye was found around the obturator nerve for 82 % of the injections performed. In addition, this study confirmed the proximity of the pelvic portion of the obturator nerve and the sacral plexus. The distance between the two structures was 2.9 ± 0.7 cm (mean ± SD).

How can the contradictory results of this cadaveric study, which showed that the colorant injected around the parasacral plexus reached the obturator nerve, and those from our clinical study, which suggested that LA does not spread from the PSB to the obturator nerve, be explained? First, the spread among the cadavers is probably very different from that in living humans. Second, the spread of latex, even if diluted with water, does not resemble the spread of LA, because of their distinct physicochemical characteristics and, in particular, their viscosity. Finally, dissection of the cadavers was performed 12–48 h after completion of the parasacral injection to enable polymerization of the latex. The presence of the dye around the obturator nerve could be explained by delayed diffusion. Even if this hypothesis is confirmed, delayed spread of LA from the sacral plexus to the obturator nerve is of no interest in the perioperative period.

One limitation of this study is that all peripheral nerve blocks were performed under nerve stimulation alone. Ultrasound guidance is commonly being used for placement of nerve blocks. Recently, ultrasonographic imaging of the obturator nerve has been defined and an ultrasound-guided technique for anesthetizing the obturator nerve has been described [23, 24]. Evaluation of anesthetic solution spread to the obturator nerve, after PSNB, under real-time visualization by use of ultrasonography or other imaging technique, could be an interesting alternative means of confirming our results. Another limitation of our study is that the control group did not receive a placebo obturator block. Therefore, time to measure the adductor muscle strength after the PSNB was slightly different between the two groups, and the patients could have noticed to which group they were allocated.

In conclusion, this clinical study demonstrated that the PSNB is an unreliable means of inducing anesthesia of the obturator nerve. In surgical procedures performed under PSNB and requiring obturator anesthesia, for example anterior cruciate ligament reconstruction, a separate ONB should be performed.

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References

1. Enneking FK, Chan V, Greger J, Hadzic A, Lang SA, Horlocker TT. Lower-extremity peripheral nerve blockade: essentials of our current understanding. Reg Anesth Pain Med. 2005;30:4–35.
2. De Tran QH, Clemente A, Finlayson RJ. A review of approaches and techniques for lower extremity nerve blocks. Can J Anesth. 2007;54:922–34.
3. Capdevila X, Barthelet Y, Biboulet P, Ryckwaert Y, Rubenovitch J, d'Athis F. Effects of perioperative analgesic technique on the surgical outcome and duration of rehabilitation after major knee surgery. Anesthesiology. 1999;91:8–15.

4. Wang H, Boctor B, Verner J. The effect of single-injection femoral nerve block on rehabilitation and length of hospital stay after total knee replacement. Reg Anesth Pain Med. 2002;27:139–44.
5. Albrect A, Wedel DJ. Orthopaedics. In: Brown DL, editor. Regional anesthesia and analgesia. Philadelphia: Saunders; 1996. p. 548–57.
6. Macalou D, Trueck S, Meuret P, Heck M, Vial F, Ouologuem S, Capdevila X, Virion JM, Bouaziz H. Postoperative analgesia after total knee replacement: the effect of an obturator nerve block added to the femoral 3-in-1 nerve block. Anesth Analg. 2004;99:251–4.
7. Sakura S, Hara K, Ota J, Tadenuma S. Ultrasound-guided peripheral nerve blocks for anterior cruciate ligament reconstruction: effect of obturator nerve block during and after surgery. J Anesth. 2010;24:411–7.
8. McNamee DA, Parks L, Milligan KR. Post-operative analgesia following total knee replacement: an evaluation of the addition of an obturator nerve block to combined femoral sciatic nerve block. Acta Anaesthesiol Scand. 2002;46:95–9.
9. Mansour NY. Reevaluating the sciatic nerve block: another landmark for consideration. Reg Anesth. 1993;18:322–3.
10. Ripart J, Cuvillon P, Nouvellon E, Gaertner E, Eledjam JJ. Parasacral approach to block the sciatic nerve: a 400-case survey. Reg Anesth Pain Med. 2005;30:193–7.
11. Cuvillon P, Ripart J, Jeannes P, Mahamat A, Boisson C, L'Hermite J, Vernes E, de La Coussaye JE. Comparison of the parasacral approach and the posterior approach, with single and double injection techniques, to block the sciatic nerve. Anesthesiology. 2003;98:1436–41.
12. Morris GF, Lang SA, Dust WN, Van der Wal M. The parasacral sciatic nerve block. Reg Anesth. 1997;22:223–8.
13. Jochum D, Iohom G, Choquet O, Macalou D, Ouologuem S, Meuret P, Kayembe F, Heck M, Mertes PM, Bouaziz H. Adding a selective obturator nerve block to the parasacral sciatic nerve block: an evaluation. Anesth Analg. 2004;99:1544–9.
14. Valade N, Ripart J, Nouvellon E, Cuvillon P, Prat-Pradal D, Lefrant JY, De La Coussaye JE. Does sciatic parasacral injection spread to the obturator nerve? An anatomic study. Anesth Analg. 2008;106:664–7.
15. Hagon B, Itani O, Bidgoli JH, Van der Linden PJ. Parasacral sciatic nerve block: does the elicited motor response predict the success rate? Anesth Analg. 2007;105:263–6.
16. Choquet O, Capdevila X, Bennourine K, Feugeas JL, Bringuier-Branchereau S, Manelli JC. A new inguinal approach for the obturator nerve block: anatomical and randomized clinical studies. Anesthesiology. 2005;103:1238–45.
17. Bouaziz H, Vial F, Jochum D, Macalou D, Heck M, Meuret P, Braun M, Laxenaire MC. An evaluation of the cutaneous distribution after obturator nerve block. Anesth Analg. 2002;9:445–9.
18. Lang SA, Yip RW, Chang P, Gerard M. The femoral 3-in-1 block revisited. J Clin Anesth. 1993;5:292–6.
19. Winnie AP, Ramamurthy S, Durrani Z. The inguinal paravascular technic of lumbar plexus anesthesia: the "3-in-1 block". Anesth Analg. 1973;52:989–96.
20. Jochum D, O'Neill T, Jabbour H, Diarra PD, Cuignet-Pourel E, Bouaziz H. Evaluation of femoral nerve blockade following inguinal paravascular block of Winnie: are there still lessons to be learnt? Anaesthesia. 2005;60:974–7.
21. Von Lanz T, Wachsmuth W. Praktische Anatomie: Bein und Statik. Berlin: Springer; 1938. p. 45–286.
22. Taboada Muniz M, Rodriguez J, Bermudez M, Valino C, Blanco N, Amor M, Aguirre P, Masid A, Cortes J, Alvarez J, Atanassoff PG. Low volume and high concentration of local anesthetic is more efficacious than high volume and low concentration in Labat's sciatic nerve block: a prospective, randomized comparison. Anesth Analg. 2008;107:2085–8.
23. Soong J, Schafhalter-Zoppoth I, Gray AT. Sonographic imaging of the obturator nerve for regional block. Reg Anesth Pain Med. 2007;32:146–51.
24. Akkaya T, Ozturk E, Comert A, Ates Y, Gumus H, Ozturk H, Tekdemir I, Elhan A. Ultrasound-guided obturator nerve block: a sonoanatomic study of a new methodologic approach. Anesth Analg. 2009;108:1037–41.